uniformity of the nanodroplets. This can be achieved by injecting the reducing agent and the precursors together, and then a higher reaction temperature can be used with TOPO or other solvents with even higher boiling points. High temperature provide improved solubility of arsenic in indium, as indicated in the In—As binary phase diagram shown in FIG. **6**, as well as conditions to achieve better crystallinity and therefore improved quality of the rods. The indium-rich part shows three phases at different temperatures. At a high temperature, In—As alloy is in the melting state; at a medium temperature, rods and indium-arsenide alloy coexists; at a temperature below the melting point of indium, rod growth stops, the two solid phases, InAs and In are separated.

The method of the present invention may be easily extended to the preparation of nanorods of other inorganic semiconductors. Other Group IIIa–Va semiconductors, e.g. InP or GaAs, can be prepared using tris(trimethylsilyl) arsine/phosphine and $InCl_3$ or $GaCl_3$ as precursors. Alloy rods can also be made in a similar fashion by proper mixing of the $InCl_3$ and $GaCl_3$ precursors (or $(TMS)_3As/P$) although the alloy composition will then also be determined by the different solubility of the different precursors in the catalytic metal particle.

Use of other catalytic metal nanodroplets having higher melting point may also provide controllable nanorod growth. As an example, the preparation of CdSe nanorods is described. Gold nanoparticles were used to catalyze and direct the growth of CdSe quantum rods. Thiol stabilized spherical gold nanocrystals have the advantage of size tunability from as small as 1 nm to tens of nanometers, narrow size distribution, and solubility in multiple solvents. Considering that the melting point of nanoparticles is reduced significantly with decreased sizes, the melting point of gold nanoparticles of appropriate sizes fall into the working temperatures of the method of the present invention, thus enabling the formation of high quality quantum rods with tunable diameters and lengths. Thus, gold nanoparticles with a diameter range of 1 to 10 nm were prepared separately [22]. These nanoparticles were made soluble in nonpolar solvents such as toluene. In the synthesis, gold nanocrystals were added either in the stock solution containing the precursors, or in the growth solution, which is TOP or TOPO or their mixtures. The reactants, dimethyl cadmium ($CdMe_2$, with a concentration range of 0.05–0.5 M) and selenium, are dissolved in TOP or tributylphoshine (TBP), with a $CdMe_2$ to Se ratio in the range of 0.8:1 to 1.4:1. The ratio between $CdMe_2$ and gold, which is critical in determining the rod length, was in a range between 5:1 and 9.5:1. The reaction was conducted by injecting the stock solution into the growth solution at an elevated temperature of about 280° C., followed by annealing at a temperature of about 260° C. for a period from a few minutes to a few hours. There were obtained CdSe quantum rods. Centrifugation steps may be used to improve the length distribution. The rods have a gold nanoparticle at one end and the rod diameters can be tuned from about 1 to about 10 nm, and lengths from 10 to 500 nm.

Rod/shell nanocrystals based on InAs nanorods, e.g. InAs/ZnSe or InAs/CdSe, may be prepared to improve the photoluminescence quantum yield and to provide further control of the optical and electronic properties of the nanorods [19, 20].

The nanorods of the present invention serve as an optical medium, which when exposed to laser radiation, produces stimulated gain emission. By changing the diameter of the rod, which can easily be controlled in the technique of the present invention (i.e., by defining a desired diameter of the metallic catalyst), the absorption and emission spectrum of the medium can be appropriately adjusted: the larger the diameter of the rod, the longer the absorption and emission wavelength. These properties of the nanorods of the present invention enable their use as amplifiers, lasing medium, and NIR light detectors.

The rod/shell nanocrystals of the present invention can be used as an optical amplifier having a stable bandwidth, in wideband optical amplifiers and lasers having adjustable center-frequency and bandwidth. In order to realize a wideband optical amplifier for amplifying data-carrying optical signals propagating in a light transmitting medium (e.g., a segment of optical fiber), a pumping, coherent-light source connected to the light transmitting medium (e.g., a segment of optical fiber) is used for exciting a plurality of semiconductor core/shell nanorods with light energy required for the amplification of the data-carrying optical signals within a specific optical band. To this end, each nanorod has core dimensions that correspond to this specific optical band and is located at a predetermined point within the light transmitting medium.

In modern data communication systems, amplification of data-carrying optical signals is typically required to compensate for losses in the magnitude of the optical signals caused by the signal propagation through an optical fiber. In the optical data communication system, a wideband optical amplifier formed by the nanorods of the present invention (or a sequence of such amplifiers) is interconnected, by segments of light transmitting medium, between a modulator connected to a data-source for modulating an optical signal with data to be carried from the data-source to a destination by the optical signal, and a demodulator located at the destination for demodulating the data-carrying optical signals.

For a variety of telecommunication purposes, there is a need for materials having emittance and optical gain as well as laser action, tunable in the Near IR (NIR) spectral range. The tunability of the band gap luminescence of the InAs nanorods over the range can be achieved by varying its diameter. By applying a shell of another semiconductor, the luminescence wavelengths of nanocrystals can be modified. A laser can be achieved by uniformly dispersing a plurality of nanorods of the present invention in a laser host medium, thereby obtaining an active lasing medium, and using a pumping source for exciting each of said nanorods, and an optical cavity that provides an optical feedback mechanism for the coherent light produced by the laser active medium.

Due to the rod-like geometry of the nanocrystals of the present invention, substantially homogeneous orientation of the long axes of the nanorods can be obtained (e.g., by stretching the nanocrystal film). This property allows for using the nanorods of the present invention as an active polarizing medium in an optical device such as light emitting diode, laser, and display, to obtain a specific polarization direction of the output light.

Those skilled in the art will readily appreciate that various modifications and changes can be applied to the present invention as hereinbefore described without departing from its scope defined in and by the appended claims.

What is claimed is:

1. A method for the production of inorganic semiconductor nanocrystals having a rod-like shape, the method comprising:

reacting, in a high-boiling point organic solvent, a two-source precursor solution comprising at least one metal source and at least one nonmetal source, or a single-